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MEMORANDUM FOR PRS (In-House Publication)

FROM: PROI (STINFO) 11 March 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-AB-2002-051**
C.T. Liu (PRSM) & Fu-Pen Chiang (UNY), "Investigating the Deformation and Failure Mechanisms in Bi-Material Systems under Tension"

14th U.S. National Congress Theoretical & Applied Mechanics **(Statement A)**
(Blacksburg, VA, 23-28 June 2002) (Deadline: 12 April 2002)

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Investigating the Deformation and Failure Mechanisms in Bi-Material Systems under Tension

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Bonded sandwich laminates are being used widely in various industries. They have been successfully used in aircraft and space structures, pipes, chemical tanks, ship hulls, and in other structural applications in which a high strength-to-weight ratio is a desirable feature.

Joining structural components with adhesives provides a number of advantages. Bonding does not require rivet holes, which are stress raisers and may cause premature failure either under static or fatigue loading. In fact, it has been shown that the fatigue strength of a stiffened panel in an aircraft structure is considerably improved when the stiffeners are bonded to the panel. The bonding of damping materials to metal sheets, to form a sandwich structure, currently is being considered as an effective way to control noise-induced fatigue (sonic fatigue) of airframes. In solid rocket motor design, the bonding of insulation materials to motor casings is used to protect the casing from high temperature after the motor is fired.

It is well known that there are imperfections existing in bonded systems. These imperfections may be produced during the fabrication process of the systems. In analyzing the strength of the bonded system, the localized imperfection may be idealized as a crack in the material. In addition to the imperfections, cracks also can be developed in the material by service loads during the life of the structures. In determining the residual strength or the remaining service life of a bonded structure with cracks, the constitutive behavior of the bonded systems needs to be determined.

In this study, the strain distributions and the constitutive relations in a bonded bi-material specimen under a constant displacement rate of 0.0254 cm./min. were determined using computer aided speckle interferometry techniques. Two different viscoelastic materials were used to make sandwiched specimens. The two outer layers of the specimen are made of a particle-reinforced rubber, whereas the middle layer is a non-reinforced rubber. The heights of the outer layer and the middle layer are 5.08 cm. and 0.254 cm., respectively. The thickness of the specimen is 0.508 cm. and the width of the specimen varies from 0.508 cm. to 2.58 cm. The experimental data were analyzed and the effects of specimen geometry on strain distributions and failure mode in the specimen were discussed.